JC17 Rec'd PCT/PTO 09 JUL 2001

°FORM PTO-1390 (REV 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. § 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
449122006000	09/869937 Not yet Assigned

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/00011	3 January 2000	7 January 1999

TITLE OF INVENTION

METHOD FOR DETECTING TARGET OBJECTS AND FOR DETERMINING THEIR DIRECTION AND THE LIKE FOR A RADAR DEVICE (AS AMENDED)

APPLICANT(S) FOR DO/EO/US

Reiner DÖRFLER

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application under PCT Article 19 (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. [X] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information: 1. International Search Report 2. IPER w/amended sheets 3. Return receipt postcard.

CERTIFICATE OF HAND DELIVERY

I hereby certify that this correspondence is being hand filed with the United States Patent and Trademark Office in Washington, D.C. on July 9, 2001.

LaVerne Whetstone

JC18 Rec'd PCT/PTO 09 JUL 2001

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) Not yet Assigned 09/869937	INTERNATIONAL APPLICATION NO. PCT/DE00/00011	ATTORNEY'S DOCKET NUMBER. 449122006000

21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO.....$1,000.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO.....$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....$710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provision of PCT Article 33(1)-(4) $690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00

	CALCULATIONS PTO USE ONLY	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$0	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	5 - 20 =	0	x $18.00	$0	
Independent claims	1 - 3 =	0	x $80.00	$0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$0	
TOTAL OF ABOVE CALCULATIONS =				$860.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$0	
SUBTOTAL =				$860.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$0	
TOTAL NATIONAL FEE =				$860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00 per property** +				$40.00	
TOTAL FEES ENCLOSED =				$900.00	
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 900.00 to cover the above fees is enclosed.

b. ☒ The Commissioner is hereby authorized to charge any additional fees that may be required, or credit any overpayment to **Deposit Account No. 03-1952**.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kevin R. Spivak
Morrison & Foerster LLP
2000 Pennsylvania Avenue, N.W.
Washington, D.C. 20006-1888

SIGNATURE

Kevin R. Spivak
Registration No. 43,148

09/869937

PATENT

Docket No. 449122006000

CERTIFICATE OF HAND DELIVERY

JC18 Rec'd PCT/PTO 09 JUL 2001

I hereby certify that this correspondence is being hand filed with the United States Patent and Trademark Office in Washington, D C. on July 9, 2001.

LaVerne Whetstone

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of:

Reiner DÖRFLER

Serial No.: Not yet Assigned

Filing Date: July 9, 2001

For: METHOD FOR DETECTING TARGET OBJECTS AND FOR DETERMINING THEIR DIRECTION AND THE LIKE FOR A RADAR DEVICE (AS AMENDED)

Examiner: Not yet Assigned

Group Art Unit: Not yet Assigned

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination on the merits, please amend this application as follows:

In the Specification:

On page 1, before the first paragraph, please insert the following paragraph:

This application claims priority to International Application No. PCT/DE00/00011 which was published in the German language on July 13, 2000.

Page 1 before the first paragraph, please delete the following:

~~Description~~

Please replace the title on page 1 with the following:

METHOD FOR DETECTING TARGET OBJECTS AND FOR DETERMINING THEIR DIRECTION AND THE LIKE FOR A RADAR DEVICE

On page 1, between lines 6 and 7, please insert the following heading:

TECHNICAL FIELD OF THE INVENTION

On page 1, between lines 10 and 11, please insert the following heading:

BACKGROUND OF THE INVENTION

Please replace the paragraph beginning on page 1, line 11, with the following rewritten paragraph:

As disclosed, for example, in EP 0 727 051 B1, radar technology has become important for use in the motor vehicle industry to the extent that safety standards for a motor vehicle must be continuously adapted as the traffic density becomes ever greater. Radar devices have been designed to detect both stationary target objects and target objects moving relative to a motor vehicle, without making any contact with them. These devices can determine their range, speed, condition, presence, direction, etc. The radar devices used for this purpose are essentially based on two main traffic techniques relating to radar technology, which are known by the names "simultaneous lobing" and "sequential lobing".

Please replace the paragraph beginning on page 1, line 11, with the following rewritten paragraph:

The term "simultaneous lobing" means a monopulse radar technique. The radar devices used to implement this technique and which use this technique include a transmitting and receiving device having typically 2 (one-dimensional) or 4 (two-dimensional) detection areas, which partially overlap and are evaluated simultaneously. The aim is to obtain an accurate

measurement of the position angle of the target object with respect to the radar device axis by means of intensity comparison. Angular resolution is not feasible, that is to say two or more objects at the same distance cannot as such be resolved separately from one another, since only a single object is detected rather than the at least two objects and, furthermore, this object is associated with an incorrect position angle.

On page 2, between lines 15 and 16, please insert the following paragraph:

The document US 5 598 163 discloses a multibeam radar system, which has a number of transmitting and receiving devices. The detection area of the radar system in this case comprises the beam fields of the receiving devices. The echo signals are in this case evaluated using the monopulse method.

On page 2, between lines 23 and 24, please insert the following headings and paragraphs:

SUMMARY OF THE INVENTION

In one embodiment of the invention, there is a method for detecting target objects using a radar device, including arranging at least three transmitting and receiving devices for radar beams such that their beam fields form a detection area of the radar device; activating and deactivating the at least three transmitting and receiving devices such that at least two adjacent transmitting and receiving devices are operated simultaneously; and evaluating the echo signals from the transmitting and receiving devices using the monopulse method.

In one aspect of the invention, one pair of adjacent transmitting and receiving devices are activated simultaneously.

In another aspect of the invention, at least one of the currently deactivated transmitting and receiving devices is reactivated for activation of the at least two transmitting and receiving devices.

In yet another aspect of the invention, the echo signals from the transmitting and receiving devices are evaluated individually on the basis of range, speed and intensity.

In still another aspect of the invention, the position angle of the target object relative to the radar device is determined by comparison of the intensities of the at least two transmitting and receiving devices.

BRIEF DESCRIPTION OF THE DRAWINGS

Details and features of the invention can be found in the following description, in which:

Figure 1 shows a perspective view of a passenger vehicle which has a radar device according to the invention.

Figure 2 shows a schematic illustration of the radar device with its individual beam fields.

Figure 3 shows a block diagram of a radar device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please replace the paragraph beginning on page 2, line 24, with the following rewritten paragraph:

In one embodiment of the invention, there is a method of the type which achieves particularly high position angle measurement accuracy by avoiding fluctuation errors in the measurement process, and nevertheless allows resolution between a number of objects at the same distance.

Please replace the paragraph beginning on page 2, line 31, with the following rewritten paragraph:

This is achieved in one embodiment by arranging at least three transmitting and receiving devices for radar beams in a radar device in such a manner that their beam fields form the detection area of the radar device, and by successively activating and deactivating the at least three transmitting and receiving devices in such a manner that at least two adjacent transmitting and receiving devices are operated simultaneously. To this extent, the overall detection area of the radar device in the method according to the invention is subdivided into a number of area elements, in this case referred to as beam fields, which, in pairs or else in groups of a number of them, form a detection area element, which scans the entire detection area successively. The terms successive activation and deactivation in this case mean that the beam fields are not all active at the same time. The number of transmitting and receiving devices to be activated for one detection area element may also vary during a scanning process. Using a method such as this, the advantages of the two known methods "simultaneous lobing" and "sequential lobing" are combined in one method or in one device form in such a manner that the specific disadvantages of each of the known methods are also compensated for.

Please replace the paragraph beginning on page 3, line 16, with the following rewritten paragraph:

In another embodiment, a small detection area element which includes two transmitting and receiving devices is intended to be created, which effectively ensures accurate, step-by-step scanning of the entire detection area of the radar device.

Please replace the paragraph beginning on page 3, line 24, with the following rewritten paragraph:

In another embodiment of the invention, there is a sequence of a radar scan covering the entire detection area. This sequence comprises overlapping of successively activated detection area elements by at least one beam field of a transmitting and receiving device. For example, after deactivation of one pair of transmitting and receiving devices, a new pair is defined for activation in such a manner that, firstly, the transmitting and receiving device which is adjacent to the currently deactivated pair is activated. Secondly, that the currently deactivated transmitting and receiving device which is adjacent to the latter is reactivated.

On page 3a, please delete lines 1-3.

On page 4, please delete lines 1-14.

Please replace the paragraph beginning on page 4, line 16, with the following rewritten paragraph:

Radar devices which operate using the method according to the invention are used in particular in motor vehicles in order, for example, to determine the range to other motor vehicles continuously. Figure 1 shows a passenger vehicle 1 which, centrally in its front area 2, has a radar device which is accommodated in the bodywork (not shown in Figure 1). This radar device has five transmitting and receiving devices, each of which emit radar beams in a known manner. Each of these beams from the transmitting and receiving devices is associated with a specific scanning area, which can be seen in Figure 1 in the form of a beam field a, b, c, d or e. Each of these beam fields a, b, c, d, e has a shape which extends conically from the radar device and

overlaps the respectively adjacent beam field. To this extent, the illustration in Figure 1, with its touching beam fields, should be regarded only as a model illustration.

Please replace the paragraph beginning on page 5, line 6, with the following rewritten paragraph:

Figure 2 illustrates the beam field arrangement of the radar device 3. The beam fields a, b, c, d, e are dimensioned to be of the same size and are arranged in such a manner that they overlap their respectively adjacent beam field. The extent of the overlap between the beam fields a, b, c, d, e is approximately half the width of one beam field. The detection area 4 is bounded by the two outer beam fields a and e and has a shape which extends in divergent manner from the radar device 3 in the detection plane.

Please replace the paragraph beginning on page 5a, line 1, with the following rewritten paragraph:

It can be seen from this that the transmitting and receiving devices A, B, C, D and E are each activated in pairs, thus producing four different beam field pairs a/b, b/c, c/d, d/e. The transmitting and receiving devices are thus continuously switched on and off in pairs. This makes it possible to achieve particularly high position angle accuracy for a target object since, (a) a number of beam fields, in this case five, are used, and (b) activation of beam pairs avoids the angle measurement errors resulting from signal fluctuation.

On page 8, line 1, please replace "Patent Claims" with --WHAT IS CLAIMED IS--.

In the claims:

1. (Amended) A method for detecting target objects using a radar device, comprising:

arranging at least three transmitting and receiving devices for radar beams such that their beam fields form a detection area of the radar device;

activating and deactivating the at least three transmitting and receiving devices such that at least two adjacent transmitting and receiving devices are operated simultaneously; and

evaluating the echo signals from the transmitting and receiving devices using the monopulse method.

2. (Amended) The method as claimed in claim 1, wherein one pair of adjacent transmitting and receiving devices are activated simultaneously.

3. (Amended) The method as claimed in claim 1, wherein at least one of the currently deactivated transmitting and receiving devices is reactivated for activation of the at least two transmitting and receiving devices.

4. (Amended) The method as claimed in claim 1, wherein the echo signals from the transmitting and receiving devices are evaluated individually on the basis of range, speed and intensity.

5. (Amended) The method as claimed in claim 3, wherein the position angle of the target object relative to the radar device is determined by comparison of the intensities of the at least two transmitting and receiving devices.

In the Abstract:

Please replace the Abstract in its entirety with the Abstract attached hereto.

REMARKS

The above amendments to the specification, claims and abstract have been made to place the application in proper U.S. format and to conform with proper grammatical and idiomatic English. None of the amendments herein are made for reasons related to patentability. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**".

In the event that the transmittal letter is separated from this document and the Patent and Trademark Office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing docket no. 449122006000. However, the Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Respectfully submitted,

Dated: July 9, 2001

By: _____
Kevin R. Spivak
Registration No. 43,148

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2000 Pennsylvania Avenue, N.W.
Washington, D.C. 20006-1888
Telephone: (202) 887-6924
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

For the convenience of the Examiner, the changes made are shown below with deleted text in strikethrough and added text in underline.

In the Specification:

On page 1, before the first paragraph, please insert the following paragraph:

This application claims priority to International Application No. PCT/DE00/00011 which was published in the German language on July 13, 2000.

Page 1 before the first paragraph, please delete the following:

~~Description~~

Please replace the title on page 1 with the following:

METHOD FOR DETECTING TARGET OBJECTS AND FOR DETERMINING THEIR DIRECTION AND THE LIKE FOR A RADAR DEVICE

On page 1, between lines 6 and 7, please insert the following heading:

TECHNICAL FIELD OF THE INVENTION

On page 1, between lines 10 and 11, please insert the following heading:

BACKGROUND OF THE INVENTION

Paragraph beginning on page 1, line 11 has been amended as follows:

As ~~is~~ disclosed, for example, in EP 0 727 051 B1, radar technology has ~~also~~ become important for use in the motor vehicle industry to the extent that safety standards for a motor vehicle must be continuously adapted as the traffic density becomes ever greater. Radar devices have been designed ~~for this purpose which are intended~~ to detect both stationary target objects and target objects moving relative to a motor vehicle, without making any contact with them~~,~~. ~~in~~

~~order to~~ These devices can determine their range, speed, condition, presence, direction, etc. The radar devices used for this purpose are essentially based on two main traffic techniques relating to radar technology, which are known by the names "simultaneous lobing" and "sequential lobing".

Paragraph beginning on page 1, line 11 has been amended as follows:

The term "simultaneous lobing" means a monopulse radar technique. The radar devices used to implement this technique and which use this technique ~~contain~~ include a transmitting and receiving device having typically 2 (one-dimensional) or 4 (two-dimensional) detection areas, which partially overlap and are evaluated simultaneously. The aim is ~~in this way~~ to obtain an accurate measurement of the position angle of the target object with respect to the radar device axis by means of intensity comparison. Angular resolution is not feasible, that is to say two or more objects at the same distance cannot as such be resolved separately from one another, since only a single object is detected rather than the at least two objects and, furthermore, this object is associated with an incorrect position angle.

On page 2, between lines 15 and 16, please insert the following paragraph:

The document US 5 598 163 discloses a multibeam radar system, which has a number of transmitting and receiving devices. The detection area of the radar system in this case comprises the beam fields of the receiving devices. The echo signals are in this case evaluated using the monopulse method.

On page 2, between lines 23 and 24, please insert the following headings and paragraphs:

SUMMARY OF THE INVENTION

In one embodiment of the invention, there is a method for detecting target objects using a radar device, including arranging at least three transmitting and receiving devices for radar beams such that their beam fields form a detection area of the radar device; activating and

deactivating the at least three transmitting and receiving devices such that at least two adjacent transmitting and receiving devices are operated simultaneously; and evaluating the echo signals from the transmitting and receiving devices using the monopulse method.

In one aspect of the invention, one pair of adjacent transmitting and receiving devices are activated simultaneously.

In another aspect of the invention, at least one of the currently deactivated transmitting and receiving devices is reactivated for activation of the at least two transmitting and receiving devices.

In yet another aspect of the invention, the echo signals from the transmitting and receiving devices are evaluated individually on the basis of range, speed and intensity.

In still another aspect of the invention, the position angle of the target object relative to the radar device is determined by comparison of the intensities of the at least two transmitting and receiving devices.

BRIEF DESCRIPTION OF THE DRAWINGS

Details and features of the invention can be found in the following description, in which:

Figure 1 shows a perspective view of a passenger vehicle which has a radar device according to the invention.

Figure 2 shows a schematic illustration of the radar device with its individual beam fields.

Figure 3 shows a block diagram of a radar device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Paragraph beginning on page 2, line 24 has been amended as follows:

~~The object of the~~ In one embodiment of the invention, there is ~~to provide~~ a method of ~~said~~ the type which achieves particularly high position angle measurement accuracy by avoiding fluctuation errors in the measurement process, and nevertheless allows resolution between a number of objects at the same distance.

Paragraph beginning on page 2, line 31 has been amended as follows:

This ~~object~~ is achieved in one embodiment by arranging at least three transmitting and receiving devices for radar beams in a radar device in such a manner that their beam fields form the detection area of the radar device, and by successively activating and deactivating the at least three transmitting and receiving devices in such a manner that at least two adjacent transmitting and receiving devices are operated simultaneously. To this extent, the overall detection area of the radar device in the method according to the invention is subdivided into a number of area elements, in this case referred to as beam fields, which, in pairs or else in groups of a number of them, form a detection area element, which scans the entire detection area successively. The terms successive activation and deactivation in this case mean that the beam fields are not all active at the same time. The number of transmitting and receiving devices to be activated for one detection area element may also vary during a scanning process. ~~In principle, using~~ Using a method such as this, the advantages of the two known methods "simultaneous lobing" and "sequential lobing" are combined in one method or in one device form in such a manner that the specific disadvantages of each of the known methods are also compensated for.

Paragraph beginning on page 3, line 16, has been amended as follows:

~~Claim 2 provides a precise definition of the method according to the invention. In this case,~~ In another embodiment, a small detection area element which includes ~~only~~ two

transmitting and receiving devices is intended to be created, which effectively ensures accurate, step-by-step scanning of the entire detection area of the radar device.

Paragraph beginning on page 3, line 24, has been amended as follows:

In another embodiment of the invention, there is a sequence of a radar scan covering the entire detection area. This sequence comprises overlapping of successively activated detection area elements by at least one beam field of a transmitting and receiving device. For example, after deactivation of one pair of transmitting and receiving devices, a new pair is defined for activation in such a manner that, firstly, the transmitting and receiving device which is adjacent to the currently deactivated pair is activated~~,~~. Secondly, ~~secondly~~ that the currently deactivated transmitting and receiving device which is adjacent to the latter is reactivated.

On page 3a, please delete lines 1-3:

~~Claims 4 and 5 specify how and using which methods the echo signals produced by the method according to the invention are preferably evaluated.~~

On page 4, please delete lines 1-14:

~~Further advantages, details and features of the invention can be found in the following description, in which an exemplary embodiment of the method according to the invention is explained in more detail with reference to the attached drawings, in which:~~

~~Figure 1 shows a perspective view of a passenger vehicle which has a radar device according to the invention;~~

~~Figure 2 shows a schematic illustration of the radar device with its individual beam fields; and~~

~~Figure 3 shows a block diagram of a radar device.~~

Paragraph beginning on page 4, line 16, has been amended as follows:

Radar devices which operate using the method according to the invention are used in particular in motor vehicles in order, for example, to determine the range to other motor vehicles continuously. Figure 1 shows a passenger vehicle 1 which, centrally in its front area 2, has a radar device which is accommodated in the bodywork~~, but is~~ (not shown in Figure 1). This radar device has five transmitting and receiving devices, ~~which~~ each of which emit radar beams in a known manner. Each of these beams from the transmitting and receiving devices is associated with a specific scanning area, which can be seen in Figure 1 in the form of a beam field a, b, c, d or e. Each of these beam fields a, b, c, d, e has a shape which extends conically from the radar device and overlaps the respectively adjacent beam field. To this extent, the illustration in Figure 1, with its touching beam fields, should be regarded only as a model illustration.

Paragraph beginning on page 5, line 6, has been amended as follows:

Figure 2 ~~explicitly~~ illustrates the beam field arrangement of the radar device 3. The beam fields a, b, c, d, e are dimensioned to be of the same size and are arranged in such a manner that they overlap their respectively adjacent beam field. The extent of the overlap between the beam fields a, b, c, d, e is approximately half the width of one beam field. The detection area 4 is bounded by the two outer beam fields a and e and has a shape which extends in divergent manner from the radar device 3 in the detection plane.

Paragraph beginning on page 5a, line 1, has been amended as follows:

It can be seen from this that the transmitting and receiving devices A, B, C, D and E are each activated in pairs, thus producing four different beam field pairs a/b, b/c, c/d, d/e. The

transmitting and receiving devices are thus continuously switched on and off in pairs. This makes it possible to achieve particularly high position angle accuracy for a target object since, ~~firstly,~~ (a) a number of beam fields, in this case five, are used, and~~, secondly,~~ (b) activation of beam pairs avoids the angle measurement errors resulting from signal fluctuation.

On page 8, line 1, please replace "Patent Claims" with --WHAT IS CLAIMED IS--.

In the claims:

1. (Amended) A method for detecting target objects using ~~and for determining their direction, range, speed and the like for~~ a radar device ~~(3) in particular for use in motor vehicles~~, comprising ~~the following method steps~~:

~~arrangement of~~ arranging at least three transmitting and receiving devices ~~(A, B, C, D, E)~~ for radar beams ~~in~~ such ~~a manner~~ that their beam fields ~~(a, b, c, d, e)~~ form ~~the~~ a detection area ~~(4)~~ of the radar device ~~(3),~~;

~~successive activation and deactivation of~~ activating and deactivating the at least three transmitting and receiving devices ~~(A, B, C, D, E) in~~ such ~~a manner~~ that at least two adjacent transmitting and receiving devices are operated simultaneously~~,~~; and

~~evaluation of~~ evaluating the echo signals from the transmitting and receiving devices ~~(A, B, C, D, E)~~ using the monopulse method.

2. (Amended) The method as claimed in claim 1, ~~characterized in that one, and only one,~~ wherein one pair of adjacent transmitting and receiving devices ~~(A, B, C, D, E)~~ are activated simultaneously.

3. (Amended) The method as claimed in claim 1 ~~one of claims 1 or 2~~, ~~characterized in that~~ wherein at least one of the currently deactivated transmitting and receiving devices

~~(A, B, C, D, E)~~ is reactivated for activation of the at least two transmitting and receiving devices ~~(A, B, C, D, E)~~.

4. (Amended) The method as claimed in claim 1, wherein~~one of claims 1 to 3, characterized in that~~ the echo signals from the transmitting and receiving devices ~~(A, B, C, D, E)~~ are evaluated individually on the basis of range, speed and intensity.

5. (Amended) The method as claimed in claim 3, wherein ~~one of claims 1 to 4, characterized in that~~ the position angle of the target object relative to the radar device ~~(3)~~ is determined by comparison of the intensities of the at least two transmitting and receiving devices ~~(A, B, C, D, E)~~.

In the Abstract:

Please replace the Abstract in its entirety with the Abstract attached hereto.

METHOD FOR DETECTING TARGET OBJECTS AND FOR DETERMINING THEIR DIRECTION AND THE LIKE FOR A RADAR DEVICE

Abstract

In a method for detecting target objects and determining their direction, range, speed and the like for a radar device, the invention provides that at least three transmitting and receiving devices for radar beams are arranged in such a manner that their beam fields (a, b, c, d, e) form the detection area of the radar device, and the at least three transmitting and receiving devices are activated and deactivated successively in such a manner that at least two adjacent transmitting and receiving devices are activated simultaneously.

3/PRTS

09/869937

JC18 Rec'd PCT/PTO 09 JUL 2001

Description

Method for detecting target objects and for determining their direction and the like for a radar device, and a radar device for use in motor vehicles

The invention relates to a method for detecting target objects and for determining their direction, range, speed and the like for a radar device.

As is disclosed, for example, in EP 0 727 051 B1, radar technology has also become important for use in the motor vehicle industry to the extent that safety standards for a motor vehicle must be continuously adapted as the traffic density becomes ever greater. Radar devices have been designed for this purpose which are intended to detect both stationary target objects and target objects moving relative to a motor vehicle without making any contact with them, in order to determine their range, speed, condition, presence, direction, etc. The radar devices used for this purpose are essentially based on two main traffic techniques relating to radar technology, which are known by the names "simultaneous lobing" and "sequential lobing".

The term "simultaneous lobing" means a monopulse radar technique. The radar devices used to implement this technique and which use this technique contain a transmitting and receiving device having typically 2 (one-dimensional) or 4 (two-dimensional) detection areas, which partially overlap and are evaluated simultaneously. The aim is in this way to obtain an accurate measurement of the position angle of the target object with respect to the radar device axis by means of intensity comparison. Angular resolution is not feasible, that is to say two or more objects at the same distance cannot as such be resolved separately from one another, since only a single object is

detected rather than the at least two objects and, furthermore, this object is associated with an incorrect position angle.

EP 0 966 690 B1

The radar technique of "sequential lobing" means the production of a number of beams with different beam fields and activation and evaluation of these beams at different times. The angular accuracy achieved in this way does not satisfy stringent demands for accurate measurement of the position angle of the target object, for use in motor vehicles. This is primarily due to the fact that, in this method, fluctuation errors which occur to a considerable extent have a very major influence on the measurement of the position angle, so that the measurements are subject to considerable intensity fluctuations. This can lead, inter alia, to misinterpretations of the position angle change when the signals are evaluated.

The document US 5 598 163 discloses a multibeam radar system, which has a number of transmitting and receiving devices. The detection area of the radar system in this case comprises the beam fields of the receiving devices. The echo signals are in this case evaluated using the monopulse method.

A known multibeam radar system for motor vehicles has at least three transmitting and receiving devices (EP 0 805 360 A2). Channel control allows the transmitting and receiving devices to be controlled in such a manner that a number of adjacent transmitting and receiving devices are operated simultaneously, and this leads to high angular resolution.

The object of the invention is to provide a method of said type which achieves particularly high position angle measurement accuracy by avoiding fluctuation errors in the measurement process, and nevertheless

allows resolution between a number of objects at the same distance.

This object is achieved by arranging at least three transmitting and receiving devices for radar beams in a radar device in such a manner that their beam fields form the detection area of the radar device, and by successively activating and deactivating the at least three transmitting and receiving devices in such a manner that at least two adjacent transmitting and

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in this case referred to as beam fields, which, in pairs or else in groups of a number of them, form a detection area element, which scans the entire detection area successively. The terms successive activation and deactivation in this case mean that the beam fields are not all active at the same time. The number of transmitting and receiving devices to be activated for one detection area element may also vary during a scanning process. In principle, using a method such as this, the advantages of the two known methods "simultaneous lobing" and "sequential lobing" are combined in one method or in one device form in such a manner that the specific disadvantages of each of the known methods are also compensated for.

Claim 2 provides a precise definition of the method according to the invention. In this case, a small detection area element which includes only two transmitting and receiving devices is intended to be created, which effectively ensures accurate, step-by-step scanning of the entire detection area of the radar device.

The development as claimed in claim 3 envisages a precise sequence of a radar scan covering the entire detection area. This sequence essentially comprises overlapping of successively activated detection area elements by at least one beam field of a transmitting and receiving device. This means that, for example, after deactivation of one pair of transmitting and receiving devices, a new pair is defined for activation in such a manner that, firstly, the transmitting and receiving device which is adjacent to the currently deactivated pair is activated and, secondly that the currently deactivated transmitting and receiving device which is adjacent to the latter is reactivated.

Claims 4 and 5 specify how and using which methods the echo signals produced by the method according to the invention are preferably evaluated.

Further advantages, details and features of the invention can be found in the following description, in which an exemplary embodiment of the method according to the invention is explained in more detail with reference to the attached drawings, in which:

Figure 1 shows a perspective view of a passenger vehicle which has a radar device according to the invention;

Figure 2 shows a schematic illustration of the radar device with its individual beam fields; and

Figure 3 shows a block diagram of a radar device.

Radar devices which operate using the method according to the invention are used in particular in motor vehicles in order, for example, to determine the range to other motor vehicles continuously. Figure 1 shows a passenger vehicle 1 which, centrally in its front area 2, has a radar device which is accommodated in the bodywork, but is not shown in Figure 1. This radar device has five transmitting and receiving devices, which each emit radar beams in a known manner. Each of these beams from the transmitting and receiving devices is associated with a specific scanning area, which can be seen in Figure 1 in the form of a beam field a, b, c, d or e. Each of these beam fields a, b, c, d, e has a shape which extends conically from the radar device and overlaps the respectively adjacent beam field. To this extent, the illustration in Figure 1, with its touching beam fields, should be regarded only as a model illustration.

According to the invention, the radar device acts in such a way that one pair of transmitting and receiving

devices are successively activated simultaneously, while the remaining three transmitting and receiving devices are deactivated. At the instant in the scanning process

shown in Figure 1, those transmitting and receiving devices whose beam fields are b and c are activated, and those transmitting and receiving devices whose beam fields are a, d and e are deactivated.

Figure 2 explicitly illustrates the beam field arrangement of the radar device 3. The beam fields a, b, c, d, e are dimensioned to be of the same size and are arranged in such a manner that they overlap their respectivelty adjacent beam field. The extent of the overlap between the beam fields a, b, c, d, e is approximately half the width of one beam field. The detection area 4 is bounded by the two outer beam fields a and e and has a shape which extends in divergent manner from the radar device 3 in the detection plane.

In order to achieve particularly reliable coverage of the detection area 4, the radar device 3 according to the invention preferably operates in accordance with the sequence shown in Table 1, below.

	Beam pair a/b	Beam pair b/c	Beam pair c/d	Beam pair d/e
Transmitter + receiver A	on	off	off	off
Transmitter + receiver B	on	on	off	off
Transmitter + receiver C	off	on	on	off
Transmitter + receiver D	off	off	on	on
Transmitter + receiver E	off	off	off	on
IF output I	beam a	beam b	beam c	beam d
IF output II	beam b	beam c	beam d	beam e

Table 1

It can be seen from this that the transmitting and receiving devices A, B, C, D and E are each activated in pairs, thus producing four different beam field pairs a/b, b/c,

c/d, d/e. The transmitting and receiving devices are thus continuously switched on and off in pairs. This makes it possible to achieve particularly high position angle accuracy for a target object since, firstly, a number of beam fields, in this case five, are used, and, secondly, activation of beam pairs avoids the angle measurement errors resulting from signal fluctuation.

A scanning process for the detection area 4 comprises successive activation of transmitting and receiving device pairs from left to right or from right to left (see Figure 1). In this sequence, after the deactivation of a beam pair b/c, for example, the new transmitting and receiving device pair c/d is then activated, followed by the transmitting and receiving device pair d/e, etc. This results in a scanning process which has a further overlapping detection characteristic, due to the renewed activation of a deactivated transmitting and receiving device.

The radar device 3, which operates using the method according to the invention, is illustrated in Figure 4. It comprises a voltage controlled oscillator 5, which produces an operating frequency in a band, which is normal for passenger vehicle applications, in a range from 76 to 77 GHz. Gunn diodes or HEMTs are particularly suitable for this purpose. The operating frequency is passed to a distributor 6 which supplies the radar signals to the respective transmitting and receiving devices A, B, C, D and E. The distribution can be carried out, for example, by means of passive dividers or by appropriate RF switches. The transmitting and receiving devices A to E are each connected to an antenna 7 for the beam fields

A to E. The transmitting and receiving devices A to E each have a control line input 8 and an IF signal output 9. The control line inputs 8 are connected to a switching device 10, which is controlled by a control unit, which is not illustrated. The above components can be provided, for example, by using a microprocessor. If, now,

for example, the transmitting and receiving devices B and C are activated during a scanning process, the switch 10 is switched such that a signal is supplied via the corresponding control lines 11 to the control line inputs 8 of the transmitting and receiving devices B and C. This signal activates the two selected transmitting and receiving devices B and C. Received echo signals are supplied via the IF signal outputs 9 from the transmitting and receiving devices B and C to the switch 10 as an intermediate-frequency signal (IF signal) via IF signal lines 12. These signals are passed on via IF outputs I, II to the control unit in order to evaluate them. The last two lines in Table 1 show which of the echo signals is supplied via the IF outputs I, II by the switch 10 to the control device during the method sequence.

Patent Claims

1. A method for detecting target objects and for determining their direction, range, speed and the like for a radar device (3) in particular for use in motor vehicles, comprising the following method steps:
   - arrangement of at least three transmitting and receiving devices (A, B, C, D, E) for radar beams in such a manner that their beam fields (a, b, c, d, e) form the detection area (4) of the radar device (3),
   - successive activation and deactivation of the at least three transmitting and receiving devices (A, B, C, D, E) in such a manner that at least two adjacent transmitting and receiving devices are operated simultaneously, and
   - evaluation of the echo signals from the transmitting and receiving devices (A, B, C, D, E) using the monopulse method.

2. The method as claimed in claim 1, characterized in that one, and only one, pair of adjacent transmitting and receiving devices (A, B, C, D, E) are activated simultaneously.

3. The method as claimed in one of claims 1 or 2, characterized in that at least one of the currently deactivated transmitting and receiving devices (A, B, C, D, E) is reactivated for activation of the at least two transmitting and receiving devices (A, B, C, D, E).

4. The method as claimed in one of claims 1 to 3, characterized in that the echo signals from the

transmitting and receiving devices (A, B, C, D, E) are evaluated individually on the basis of range, speed and intensity.

5. The method as claimed in one of claims 1 to 4, characterized in that the position angle of the target object relative to the radar device (3) is determined by comparison of the intensities of the at least two transmitting and receiving devices (A, B, C, D, E).

GR 99 P 1006 Foreign version

Abstract

Method for detecting target objects and for determining their direction and the like for a radar device, and a radar device for use in motor vehicles

In a method for detecting target objects and determining their direction, range, speed and the like for a radar device, the invention provides that at least three transmitting and receiving devices for radar beams are arranged in such a manner that their beam fields (a, b, c, d, e) form the detection area of the radar device, and the at least three transmitting and receiving devices are activated and deactivated successively in such a manner that at least two adjacent transmitting and receiving devices are activated simultaneously.

Figure 1

DE 199 38 266 A1

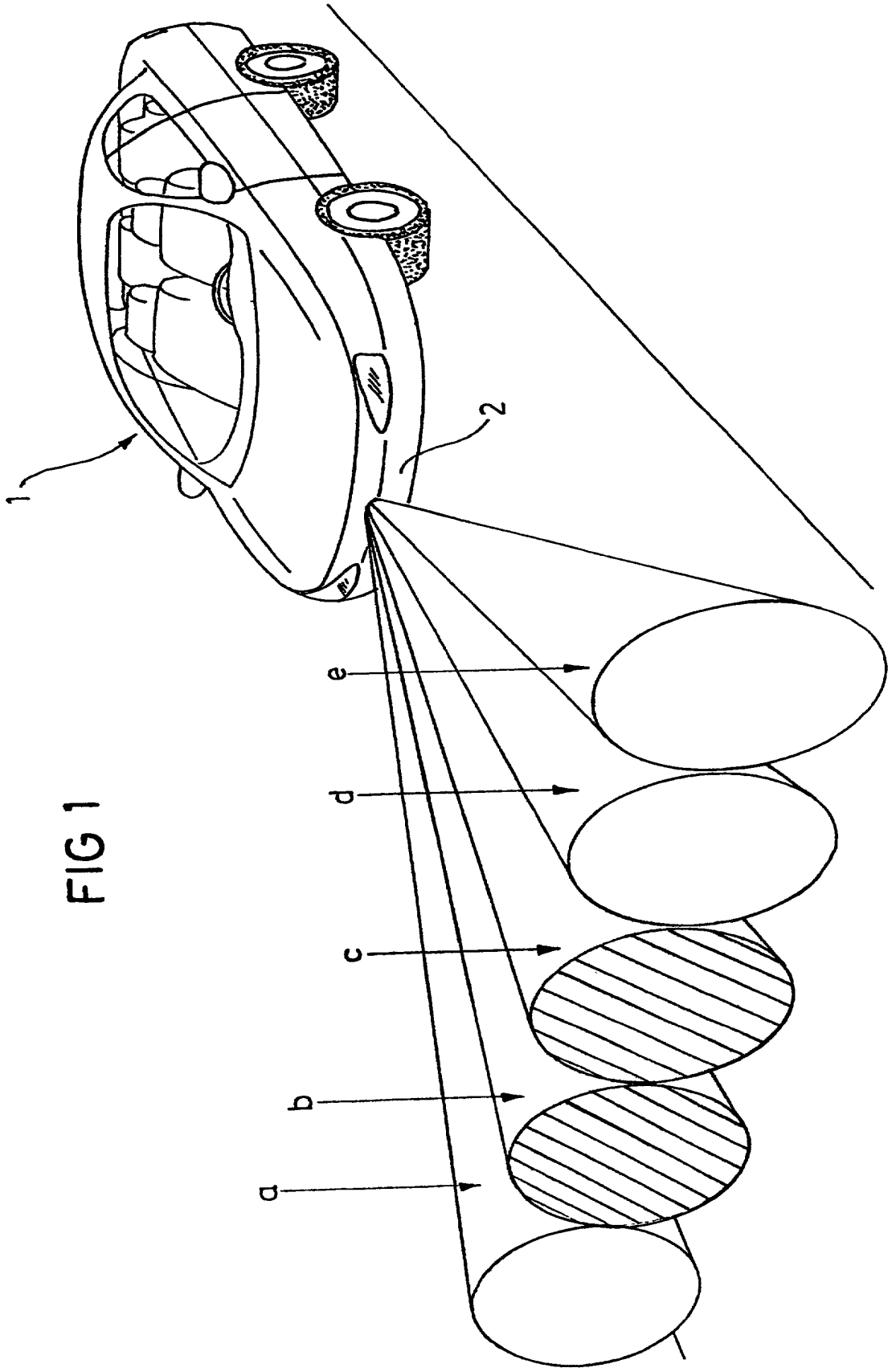

FIG 1

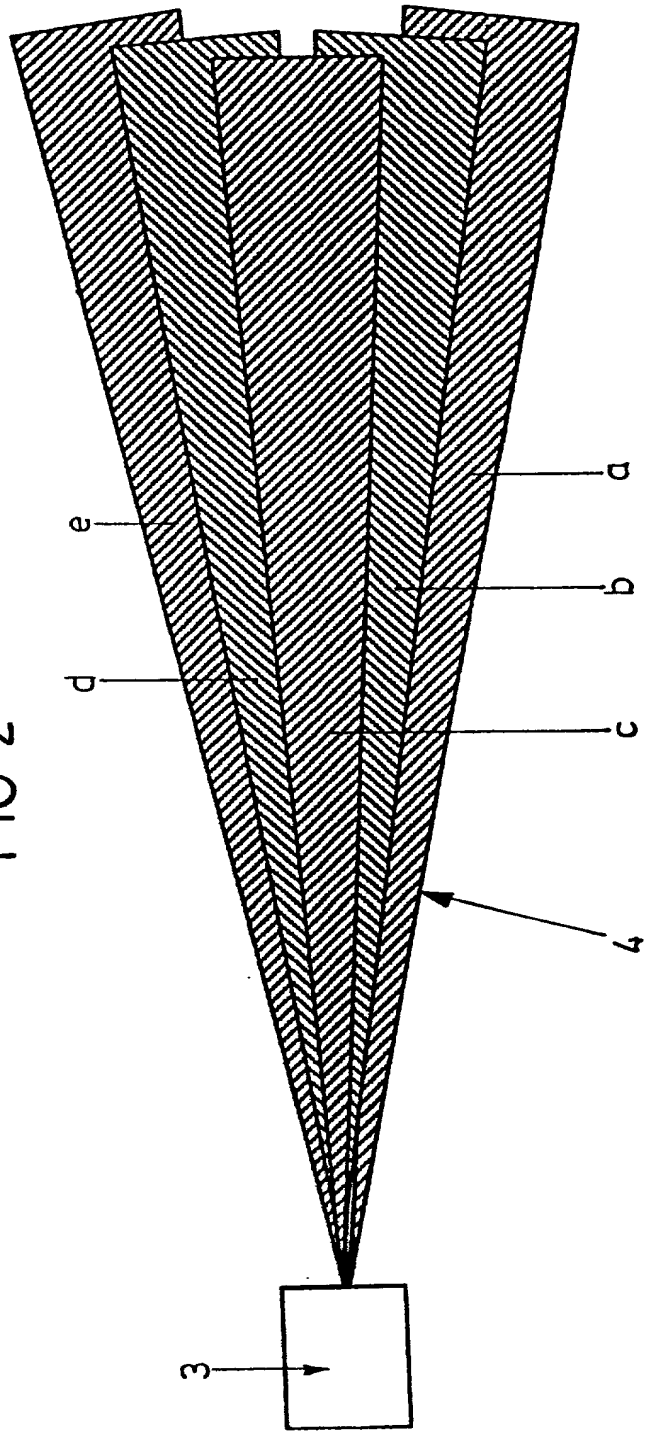

FIG 2

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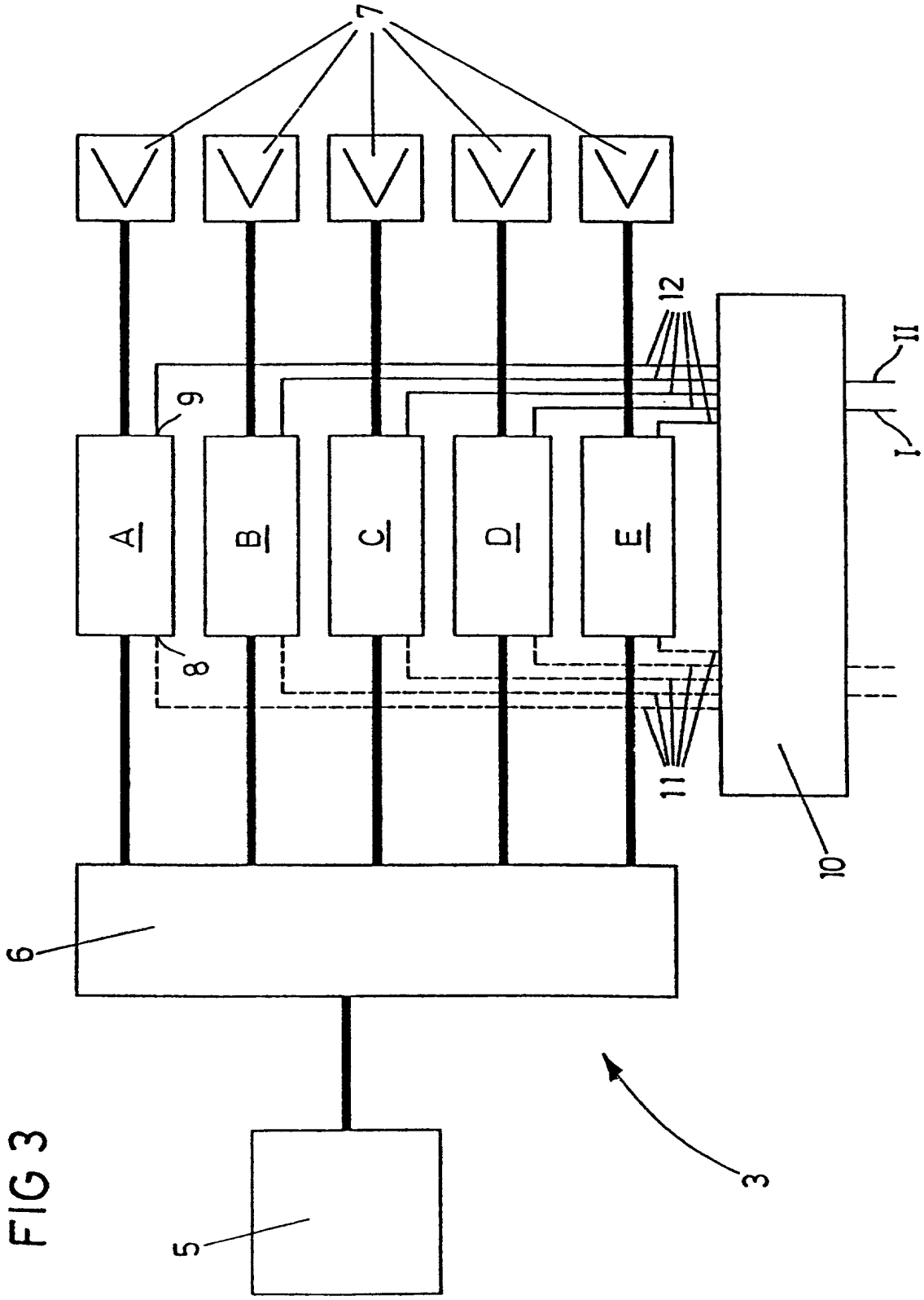

FIG 3

German Language Declaration

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Unterschrift des Erfinders Datum	Second Inventor's signature Date
Wohnsitz ,	Residence ,
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

German Language Declaration

Prior foreign appplications
Priorität beansprucht

			Priority Claimed	
19900328.9	DE	07.01.1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/00011 (Application Serial No.) (Anmeldeseriennummer)	03.01.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	_____ (Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
_____ (Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	_____ (Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Verfahren zur Erfassung von Zielobjekten und zur Bestimmung deren Richtung fuer ein Radargeraet in Kraftfahrzeugen

Method for detecting targets and for determining their direction for a radar device in a motor vehicle

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 03.01.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/00011
eingereicht wurde und am ________
abgeändert wurde (falls tatsächlich abgeändert).

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 03.01.2000 as
PCT international application
PCT Application No. PCT/DE00/00011
and was amended on ___________
(if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

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IDNR: 2590 / V: 99-1.00 / B:Val